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2d magnitude, and the tail (which extended in the direction of *Polaris*) was about 4° in length.

Elements of the comet from three observations at Mr. Bishop's Observatory, on March 29, 30, and 31. By J. R. Hind, Esq.

Per. Pass. 1854, March 24·33842, G.M.T.

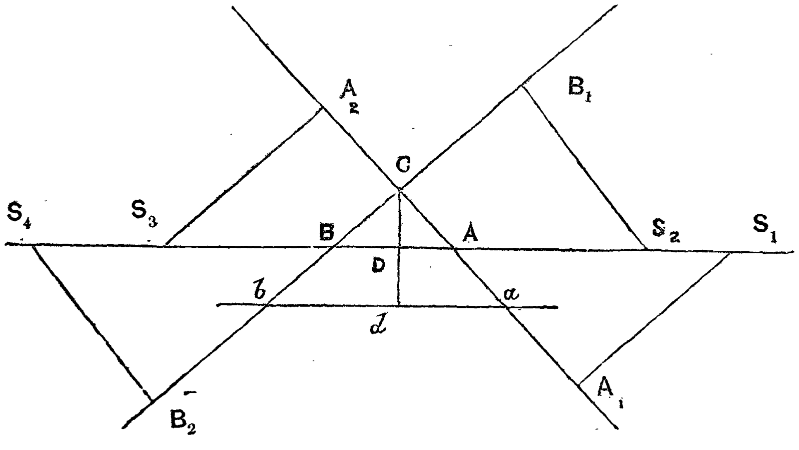
	° ′ ″	
π	207 34 8	T.E., March 30
☊	310 22 32	
i	79 27 14	
log *q*	9·445695	

Retrograde.

On a Method of Observing the Positions of Spots on the Sun; with an Example of its Application. By R. C. Carrington, Esq.

"The following method occurred to me in the month of October of last year, and has been made use of at Redhill on every subsequent occasion on which the sun has been visible. The advantages for which I would recommend it are, that it requires no previous accurate adjustment of a wire frame; that direct vision of the sun is unnecessary; that the contacts by which the position of the centre is determined are thrown to the beginning and end of the observation, so that an uninterrupted space of about three minutes is given for observing the contacts of the spots; and that the whole observation takes so little time that records may be procured on days of broken weather, when it would often be impossible otherwise to get an observation at all.

"In the focus of the equatoreal are placed two wires at right angles, turned *approximately only* into the position of 45° inclination to a parallel of declination, and the image of the sun's disk and the cross-wires is projected on a screen, placed at such a distance that the projection of the disk may measure from 12 to 14 inches. The most effective screen I have yet tried consists of a plate of ground glass, covered with whitewash, tinted a pale straw colour, with dark cloth or dead-black cartridge paper placed behind. The sun is, of course, seen to run along the screen from right to left, the true north limb being the upper limb on the screen



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" In the figure, the sun's centre is supposed to run along the line $S_1 S_4$, passing south of the intersection point C; and *a b* to be in like manner a portion of the path of a spot. When the centre has arrived at a point S_1, such that the length of the perpendicular from S_1 on either of the wires, as $S_1 A_1$, is equal to the radius of the disk, a contact of the disk with the wire will take place, the instant of which is to be observed. There will be four such contacts in all, the times of which are conveniently denoted by the letters A_1, B_1, A_2, B_2.

" The line C D *d* is supposed to be dropped perpendicular on the paths of the centre and of the spots.

" In the first instance, for simplicity, neglecting the effects of refraction, of hourly motion, and of error of verticality of the wires, we shall have by the geometry of the case,

$$\frac{BC}{2 . AB} = \frac{S_1 A_1}{S_1 S_3} = \frac{r}{15 . \sin \delta \, (A_2 - A_1)}$$

$$\frac{AC}{2 . AB} = \frac{S_2 B_1}{S_2 S_4} = \frac{r}{15 \sin \delta (B_2 - B_1)}$$

whence

$$\frac{BC}{AC} \text{ or } \tan BAC = \frac{B_2 - B_1}{A_2 - A_1}.$$

" The centre passes A at $\frac{1}{2}(A_1 + A_2)$, and B at $\frac{1}{2}(B_1 + B_2)$; and, therefore, from A to B in the time $\frac{1}{2}(B_1 + B_2) - \frac{1}{2}(A_1 + A_2)$.

$$AD = AB . \cos A . \cos A$$

$$CD = AB . \cos A . \sin A$$

" Let T stand for $\frac{1}{2}(A_1 + A_2) + AD$, and D for C D; *t* and *d* being similar quantities for a spot. Then the difference of R.A. in arc, and of N.P.D. for a spot, as compared with the sun's centre, will be

$$15 . \sin \delta . (t - T) \text{ and } 15 \sin \delta \, (d - D),$$

and the diameter of the sun will be

$$15 . \sin \delta \, (B_2 - B_1) \cos A.$$

" The quantities A B and *a b* must be considered positive when the contact at the A *a* wire precedes that at the B *b* wire, and negative in the opposite case.

" In very many instances a rough calculation on the above principle will be thought sufficient; but where two or three passages have been favourably obtained, the accuracy of the method will be found to warrant a more precise reduction in the manner following:—

" 1. The error of verticality of the wires may be found by the comparison of diameter results, when the angle B C A is changed for its supplemental angle.

" Let one angle be marked and assumed = $90° + \theta$.

" Supposing the wires to be adjusted not much out of the

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described position, there will be no difficulty in seeing that the expression for the diameter will be

$$2\,r = 15 \,.\, \sin\delta \,.\, (B_2 - B_1) \cos A \,.\, (1 - \tfrac{1}{2} \sin\theta).$$

"If the unmarked angle be now substituted, we shall have

$$2\,r = 15 \,.\, \sin\delta \,.\, (B'_2 - B'_1) \cos A'. \,(1 + \tfrac{1}{2} \sin\theta)\,;$$

from which θ may be found, if desired. The quantity actually required is the factor $(1 - \frac{1}{2} \sin\theta)$, which we will denote by the letter G, and by which all our results must be multiplied.

"2. The effect of refraction may be taken into account with sufficient accuracy by assuming every point on the disk refracted upwards in a line parallel to the vertical circle through the centre, and that the difference of refraction of any two points in the same such line is proportional to their distance. In this case, the disk will be strictly elliptic; and, in place of the radius in the previous expressions, we must substitute the expression for the perpendicular from the centre of an ellipse on its tangent.

"3. The effect of the hourly motion is disposed of by the consideration that, as the results are independent of the angle at which the sun's path cuts the wires, the motion in R.A. will affect the scale of the results only, and the motion in N.P.D. the angles only. We shall, therefore, include their effects by multiplying all our results by the well-known factor $\frac{3600}{3600 + I}$; and, by a slight transformation of co-ordinates for I′, the motion in N.P.D.

"The accurate formulæ will, accordingly, stand thus:—

$$F = 15 \,.\, \sin\delta \,.\, \frac{3600}{3600 + I} \qquad G = (1 - \tfrac{1}{2} \sin\theta)$$

$$\tan\alpha = \frac{B_2 - B_1}{A_2 - A_1} \qquad \tan\alpha' = \tan\alpha \,.\, \sqrt{\frac{1 - e^2 .\, \cos^2(\alpha + s)}{1 - e^2 .\, \sin^2(\alpha + s)}},$$

in which s is the angle contained by the great circles drawn from the sun's centre to the pole and the zenith, and is to be considered + for east hour-angles, and — for west; and in which e is the eccentricity of the disk.

$$e^2 = l\,(2 - l) \text{ where } l = k \,.\, \sec^2 z,$$

k being Bessel's factor for differential observations. As before,

$$AB = \tfrac{1}{2}(B_1 + B_2) - \tfrac{1}{2}(A_1 + A_2)$$

$$AD = AB \,.\, \cos\alpha' \,.\, \cos\alpha'$$

$$CD = AB \,.\, \cos\alpha' \,.\, \sin\alpha'$$

$$\Delta\alpha = (t - T) \,.\, F \,.\, G \qquad \Delta\delta = (d - D) \,.\, F \,.\, G.$$

"To these we must apply the corrections

$$+\Delta\delta \,.\, \frac{2\,I'}{10^5} \text{ in R.A., and } -\Delta\alpha \,.\, \frac{2\,I'}{10^5} \text{ in N.P.D.}$$

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for the hourly motion I′, which is to be considered +, when the sun's N.P.D. is increasing.

" Lastly, the corrections,

$$k \sec^2 z \,.\, \sin s \,.\, (\Delta\alpha \,.\, \sin s + \Delta\delta \,.\, \cos s) \quad \text{in R.A.}$$

and

$$k \sin^2 z \,.\, \cos s \,.\, (\Delta\alpha \,.\, \sin s + \Delta\delta \,.\, \cos s) \quad \text{in N.P.D.}$$

for difference of refraction.

" The sun's diameter will be

$$(B_2 - B_1) \,.\, F \,.\, G \,.\, \cos\alpha' \,.\, \frac{1+k}{\sqrt{1 - e^2 \sin^2(\alpha + s)}}$$

" As an example of the application of the formulæ, I have selected the observations of Nov. 25, 1853, the spots on that day being only two in number, and so situated as to illustrate the signs of the different quantities.

" The spots are denoted P and Q, and the times of passing the A *a* wire by P_a and Q_a, and of the B *b* wire by P_b and Q_b.

Bar. $29^{\text{in}}\cdot85$ Therm. $40^\circ\cdot3$

	h m s	h m s	h m s	Means. h m s
B_1	17 25 43·0	17 29 30·9	17 34 14·1	17 29 49·33
A_1	25 50·0	29 37·0	34 20·0	29 55·67
P_a	27 27·8	31 15·1	35 58·0	31 33·63
P_b	27 44·1	31 32·0	36 14·9	31 50·33
Q_b	27 45·4	31 33·4	36 16·2	31 51·67
Q_a	28 3·1	31 50·8	36 34·0	32 9·30
B_2	28 59·3	32 47·0	37 30·0	33 5·43
A_2	17 29 7·0	17 32 54·1	17 37 37·3	17 33 12·80

" The steps of the reduction will be as follow :—

$$\begin{array}{lr}
 & \text{h}\quad \text{m}\quad \text{s} \\
\tfrac{1}{2}(B_1 + B_2) = & 17\ \ 31\ \ 27\cdot38 \\
\tfrac{1}{2}(A_1 + A_2) = & 17\ \ 31\ \ 34\cdot24 \\
\text{Mean} = \text{sun's transit} = & 17\ \ 31\ \ 30\cdot8 \\
\text{Clock slow} & \underline{14\cdot4} \\
 & 17\ \ 31\ \ 45\cdot2 \\
\text{Add for longitude} & \underline{41\cdot3} \\
 & 17\ \ 32\ \ 26\cdot5
\end{array}$$

whence Greenwich mean time of observation, 1853, Nov. 25, $1^{\text{h}}\ 14^{\text{m}}\ 52^{\text{s}}\cdot5$. By the *Nautical Almanac*,

$$\alpha = 16^{\text{h}}\,4^{\text{m}}\,50^{\text{s}} \qquad I = +10^{\text{s}}\cdot65 \qquad \delta = 110^\circ\,49'\cdot3 \qquad I' = +28''\cdot7$$

whence, $z = 74^\circ\,33'$ $h = 1^{\text{h}}\,27^{\text{m}}$ west $s = -13^\circ\,56'$

" With zenith distance, barometer, and thermometer as arguments,—

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Log k = 6·4349

In our case Log G = 0·00010

whence, Log F . G = 1·14557

$B_2 - B_1$ = 196^s·10

$A_2 - A_1$ = 197·13 whence log tan α = 9·99772 α = 44° 51′

s = −13 56

$\alpha + s$ = 30 55

Log e^2 = 7·8839

whence, Log $(1 - e^2 \cos^2 \overline{\alpha + s})$ = 9·99755

Log $(1 - e^2 \sin^2 \overline{\alpha + s})$ = 9·99912

Half the diff. =9·99922, which added to log tan α gives log tan α' =9·99694; whence α' =44° 47′·9.

A B =	−6^s·860			Semidiameter.	
Log A B =	−0·83632			½ $(B_2 - B_1)$ =	98·050
Log cos α' =	9·85101			Log =	1·99145
	−0·68733		−0·68733	L cos α' =	9·85101
L cos α'	9·85101	L sin	9·84795	Log F . G =	1·14557
	−0·53834		−0·53528	Log $(1 + k)$ =	0·00012
	−3·454				2·98815
	17 31 34·235			Log $\sqrt{\ldots\ldots}$ =	9·99956
T =	17 31 30·781	D =	−3·430		2·98859
				½ diam.	974″·1
$\frac{2\,I'}{10^5}$ =	+·0006			By *Naut. Alm.*	975·0

Spot P.				Spot Q.			
$a\,b$ =	+16^s·700			$a\,b$ =	−17^s·630		
Log $a\,b$ =	+1·22272			Log $a\,b$ =	−1·24625		
L cos α'	9·85101			L cos α' =	9·85101		
	+1·07373		+1·07373		−1·09726		−1·09726
L cos α'	9·85101	L sin	9·84795	L cos α'	9·85101	L sin	9·84795
	+0·92474		+0·92168		−0·94827		−0·94521
	+8·409				−8·877		
P_a =	17 31 33·630			Q_a =	17 32 9·300		
t =	31 42·039	d =	+ 8·350	t =	32 0·423	d =	− 8·815
T =	31 30·781	D =	− 3·430	T =	31 30·781	D =	− 3·430
t−T =	+11·258	d−D =	+11·780	t−T =	+29·642	d−D =	− 5·385
Log F . G	=1·14557	and s =	−13° 56′	Log F . G	=1·14557	and s =	−13° 56′

$\therefore \Delta\alpha \,.\, \sin s + \Delta\delta \,.\, \cos s$ = +122″ whence $\therefore \Delta\alpha \,.\, \sin s + \Delta\delta \,.\, \cos s$ = −173″ whence

	$\Delta\alpha$ = +157″·4	$\Delta\delta$ = +164″·7		$\Delta\alpha$ = +414″·5	$\Delta\delta$ = −75″·3
Corr. for I′	+ 0·1	− 0·1	Corr. for I′	− 0·0	− 0·2
Diff. refr.	− 0·1	+ 0·5	Refr.	+ 0·2	− 0·6
	+157·4	+165·1		+414·7	−76·1

"The corrections applied to $\Delta\alpha$ and $\Delta\delta$ may appear small, but in cases where the spots lie further from the centre they are more necessary. It will further illustrate the method to exhibit the

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results of each passage separately, reduced without correction for refraction on the quantity I′.

	½ Diam.	Spot P.		Spot Q.	
1st set	972″·1	Δα +156″·1	Δδ +165″·3	Δα +411″·2	Δδ −72″·3
2d —	971·9	158·8	164·3	417·0	75·5
3d —	971·9	156·4	164·3	415·4	78·3

"I am not aware that the above sets are better or worse than usual, or that there exists any reason why they may not be taken as a fair sample.

"I think the time required for the whole observation will speak for itself, and I hope that the degree of accuracy attained will induce some other observer to think the method worthy a trial.

"As a last word, I would just point out that there is one objection to the use of cross bars instead of cross wires, which some might otherwise prefer. It not unfrequently happens that a group of spots of some extent lies nearly on the parallel of the sun's centre. In such a case the large space taken up by the crossing of the bars will prevent all the contacts being taken at the same passage, unless the centre be thrown to an objectionable distance from the point of intersection."

On some peculiar Features in the Structure of Lunar Volcanic Craters. By James Nasmyth, Esq.

In pursuing my investigations of the features of the lunar surface, aided by my very convenient 20-inch aperture reflecting telescope, I have been much interested in observing the details of what have hitherto been termed "terraces," namely, certain concentric ridges around the interior walls of the lunar volcanic craters; and as their peculiar features appear to me to throw some additional light on the nature of the action which had caused the formation of those remarkable "ring mountains," and which I take to be in reality the craters of extinct volcanoes, a few remarks on the subject may, perhaps, prove acceptable.

On a careful scrutiny of these concentric ridges above alluded to, I find that they are by no means continuous or regular in respect to height or position, but, on the contrary, are indented and broken, and that in many cases they form but a small segment of the interior wall of the crater; while, in other cases, portions of these "terraces" have slipped down, and that the flat bottom or plateau of the crater at the spot is covered with the *débris* of portions of the interior wall,—in short, that these features are the result of vast "*landslips*," which, when occurring to any great segment of the inner wall of the crater, yield the "terrace-like" appearance, while in a more limited extent they leave a notch or recess in the bank or cliff, and the *débris* seen at the base are the fragments of the landslip, many portions of which may be traced scattered about and projected inwards towards the centre of the